able to produce graduates who are both willing and able to widen the bounds of real knowledge.

The volume containing the studies in pathology is of such merit that the history of its origin deserves a brief mention. In reality, its preparation was commenced five-and-twenty years ago, when Sir Erasmus Wilson wisely presented the University with sufficient funds to establish a chair of pathology—the second created in this country. By a happy inspiration Prof. D. J. Hamilton was asked to occupy it. Out of the raw material provided by the surrounding country Hamilton has raised the school of pathologists which has produced the volume under review, and very fittingly dedicated it to him. The studies are seventeen in number, and illustrate the diverse directions in which pathology has branched in recent years. To the old pathology—the morbid anatomy of Rokitansky and Virchow—only three of the studies belong, those of Dr. A. Keith, on the malformations of the heart; Dr. A. Low, on epignathus; and Dr. G. Duncan, on exophthalmic goitre. Experimental pathology, a recent development, is represented by Prof. A. Cushny's excellent paper on paroxysmal irregularity of the heart, and by Dr. J. J. R. Macleod's study of the condition that follows a direct diversion of the portal blood into the systemic circulation.

All the other studies, with the exception of that by Prof. St. Clair Symmers on bilharziosis, are concerned with bacteriology—a subject which has expanded into its present gigantic proportions since Prof. Hamilton went to Aberdeen in 1882. Five of the researches deal with a matter of the very utmost importance—that of immunity. To this group belong the papers by Dr. G. Dean, on plague immunity; Dr. Wm. Bulloch, on *Bacillus pyocyaneus*; Dr. G. G. Macdonald, on pneumococcal infection; Dr. R. D. Keith, on the relationship between hæmolysis and phagocytosis of red blood corpuscles; Dr. J. G. G. Ledingham and Dr. Wm. Bulloch, on the relation of leucocytosis to the opsonic content of the blood serum. The question of infection of the body from the alimentary canal is discussed by Prof. Hamilton in connection with his investigations of the disease in sheep known as "louping-ill." The bacteria found with this disease are described by Drs. J. M. Adam and B. R. G. Russell. Dr. Wm. Hunter has employed the data he collected as bacteriologist in Hong Kong to demonstrate that there is a very direct relationship between the epidemics of plague amongst rats and men. The administrative means which may be employed for the prevention of human tuberculosis are discussed by Dr. W. L. Mackenzie; the results of experiments on the efficacy of certain disinfectants are given by Dr. A. R. Laing. The manner in which these studies have been edited and arranged reflects the greatest credit on Dr. Wm. Bulloch.

To the quatercentenary publications the Anatomical and Anthropological Society of the University contributed a special volume of its Proceedings. Prof. R. W. Reid, the president of the society, has organised a fully-equipped department of anthropology in the University, with the result that graduates bring back most valuable information regarding the people of the countries or colonies in which they have stayed, and contribute their observations to their old society. In this volume appear five papers which deal with native races. Mr. George Moir writes on the natives of the Malay Archipelago; Mr. F. S. Maxwell contributes notes on Hausaland; Mr. D. Horn deals with the people of the New Hebrides; Captain A. W. C. Young, with the Tibet mission force to Lhassa; and Dr. R. H. Spittal describes skulls of New Guinea. Important papers on ancient or prehistoric subjects are contributed by Dr. Alex. Low, by Mr. A. Macdonald, and by Dr. J. S. Milne. Dr. A. Keith writes on the results of an anthropological investigation of the external ear, and Dr. R. J. Gladstone on the variations in shape and size of the skull. The paper on the development of the lower jaw in man, by Dr. Alex. Low, deserves especial commendation, both for the importance of its facts and for the very exact and complete manner in which he has recorded his observations. There is also an excellent paper by Miss A. V. Baxter on 1500 finger-prints which are recorded in the archives of the anthropological laboratory of the University.

THE FLOWERING PLANTS OF THE MESOZOIC AGE, IN THE LIGHT OF RECENT DISCOVERIES.[1]

THE subject which I have chosen for my address relates to plants of Mesozoic or Secondary age, ranging from the Trias, through the Jurassic, to the Cretaceous, the great period which bridges the gulf between the antique vegetation of Palæozoic days and the essentially modern type of flora which characterises the Tertiary formations.

We have abundant evidence of the existence of seed-plants in very early days, in fact, practically as far back in the Palæozoic as our records of terrestrial plants extend. On this occasion, however, I am going to speak of flowering plants, by which I do not mean the same thing as seed-plants, though the two terms have often been used as synonymous. One of the results of recent discoveries in Palæozoic botany has been to show that the seed-bearing and flower-bearing characters by no means coincide, for the fern-like seed-plants of Palæozoic age were in no sense of the words flowering plants. The evidence shows that their seeds, like the fructification of ordinary ferns, were borne on leaves differing but little from the vegetative fronds, and not aggregated on any special axis as are the parts of a flower. The nearest and, indeed, the only analogy to be found among recent seed-plants is in the female plant of Cycas, to which we shall return presently. The Mesozoic plants, however, with which we are now concerned were not only seed-plants, but they bore their reproductive organs in a form which everyone would naturally describe as a flower. They were flowering plants in the full sense of the term, however different in other respects from the flowering plants of the present day.

The Mesozoic floras from the Upper Trias to the Lower Cretaceous maintain, on the whole, a very uniform character, widely different from that of the preceding Palæozoic vegetation. True ferns were abundant, more so, no doubt, than in the earlier period; true conifers, often much resembling recent genera, were a dominant group; the family now represented by the maidenhair tree (Ginkgo) was prevalent, but the most striking feature of the vegetation was the abundance, in all parts of the world, of plants belonging to the class of the cycads, now so limited a group.

We will concentrate our attention on the cycad-like plants, or Cycadophyta, to adopt the broader class-name, appropriately suggested by Prof. Nathorst. The living Cycadaceæ are, it will be remembered, quite a small family, embracing only nine genera, and, according to a recent estimate, about 100 species, inhabiting the tropical or subtropical regions of both the old and new worlds, but nowhere forming a dominant feature in the vegetation. Throughout the Mesozoic period, however, at least until the Upper Cretaceous is reached, plants with the habit and foliage of cycads are extraordinarily abundant in all regions from which secondary fossils have been obtained; they are as characteristic of Mesozoic vegetation as the dicotyledons of our recent flora.

The most important point in questions of affinity is the fructification. Throughout the recent cycads this is of a simple type; in all the genera the staminate fructification is a cone, consisting of an axis densely beset with scales or sporophylls, each sporophyll bearing on its lower surface a number—often a very large number—of pollen-sacs, grouped, like the sporangia of a fern, in small sori. In eight out of the nine genera the female fructification is also strobiloid, each sporophyll bearing two marginal ovules. In Cycas itself, however, so far as the female plant is concerned, we find a much more primitive arrangement; no cone at all is differentiated, but the carpels are borne directly on the main stem of the plant, in rosettes alternating with those of the vegetative leaves. The carpels themselves are lobed and extremely leaf-like, bearing as many as six ovules in many cases, though in one species the number is reduced to two. Thus in Cycas the seeds are borne on organs still obviously leaves, and

[1] Abridged from the presidential address delivered by Dr. D. H. Scott, F.R.S., before the Royal Microscopical Society on January 16, and published in the Journal of the Society for April.

nothing of the nature of a flower is differentiated. No other living seed-plant is so primitive as this, but the cycads as a whole are undoubtedly the most primitive family of present-day Spermophyta, as is most strikingly shown in their cryptogamic mode of fertilisation by means of spermatozoids, which they share with Ginkgo alone among seed-plants.

When we go back to the Mesozoic age we might, on what one may call the elementary view of evolution, expect to find the Cycadophytes, which were so abundant at that period, still simpler and still nearer the cryptogamic condition than the members of the class which have come down to our own day. But this is by no means the case; there were, no doubt, a certain number of cycads in Mesozoic times which were about on the same level of organisation as their living representatives, but the great majority, so far as the available evidence shows, attained a much higher organisation, at least in their reproductive arrangements, far surpassing any of the gymnosperms now known to us. This is one of the many facts in palæontology which show that evolution is by no means the obvious progression from the simple to the complex which many people have imagined. Just as the lycopods and the horsetails of the Coal-measures were not simpler, but far more complex than their successors, so the Cycadophyta of Mesozoic age were, on the whole, on a much higher level than the surviving family Cycadaceæ, which now represents them. The history of the vegetable kingdom, so far as its records are known, is the history of the ascendancy of a succession of dominant families, each of which attained at some definite period its maximum, both in extent and organisation, and then sank into comparative obscurity, or died out altogether, giving place to some other race, which, under changing conditions, was better able to assume the leading *rôle*. The cycadophytes of the Mesozoic were, in their day (and it was a long one), a dominant group, almost as much so as the dicotyledons are now, and they equipped themselves with a correspondingly high organisation, even rivalling the angiospermous flowering plants (perhaps cadets of the same stock), which ultimately displaced them.

Among the Mesozoic Cycadophyta there were some, as already mentioned, which seem to have been essentially similar to our recent cycads. I do not, however, propose to dwell on this line of descent, but will now pass on to those Mesozoic Cycadophyta which attained a higher level of organisation, giving them a better title to the name of "flowering plants" than any of their predecessors or contemporaries.

The genus Bennettites was founded by Carruthers in 1868[1] for certain cycadean stems, of Oolitic and Lower Cretaceous age, with fruits borne on secondary axes, not protruding beyond the bases of the petioles. The species on which, for many years, our knowledge of the group was principally based is *Bennettites Gibsonianus*, of which a magnificently preserved specimen was discovered, just fifty years ago, in the Lower Greensand of Luccombe Chine, in the Isle of Wight. Some years later a second specimen was found in the same locality, but no others have as yet come to light. In *B. Gibsonianus* and other species the external appearance of the stem was similar to that of many recent cycads, its surface being completely invested by an armour of persistent leaf-bases. Anatomically, there is also a marked agreement, the chief distinction consisting in the simpler course, in the case of the fossil, of the vascular strands which pass out from the stem into the leaves. A striking feature is the presence, in great numbers, on the leaf-bases and bracts, of flat, scaly hairs, of the same nature as the ramenta characteristic of ferns. Even in external appearance, however, a Bennettitean stem, if in the fruiting condition, differs conspicuously from that of any recent cycad in the presence of a number of short, lateral branches, like large buds, wedged in between the leaf-bases, and arising in their axils (see Fig. 1, from an American species). These bodies are the fructifications, the characteristic feature of the Bennettiteæ. In structure, as well as in position, they differ totally from any form of fructification met with in recent cycads or other gymnosperms.

The peduncle bears many spirally arranged bracts, which completely enclose the fructification. The end of this peduncle expands into a convex receptacle, on which organs of two kinds are borne, the one fertile, the other sterile. The fertile appendages consist each of a long, slender pedicel, terminating in a single orthotropous seed, with the micropyle directed outwards. The seed-bearing pedicels are present in large numbers; the sterile appendages, or interseminal scales, are still more numerous. They form a dense packing between the seed-pedicels, and somewhat overtop the seeds themselves, expanding at their apices to form an almost continuous envelope, leaving only small perforations, into which the micropylar ends of the seeds are fitted. They form collectively a kind of pericarp, differing, however, from that of an angiospermous fruit in the presence of openings for the micropyles of the seeds. The whole complex fruit is enclosed in the mantle of overlapping bracts. In *Bennettites Gibsonianus* the fruits discovered are practically ripe, for each seed contains a large dicotyledonous embryo, with somewhat fleshy cotyledons The embryo almost fills the seed, which was thus nearly if not quite, exalbuminous—an unprecedented condition in

FIG. 1.—*Cycadeoidea marylandica*. The earliest described American fossil Cycad. From an original daguerreotype. Nearly thirty young fruits are marked in the present view by the groups of bract scars interpolated between the old leaf-bases. About one-fourth natural size. From Wieland's "American Fossil Cycads."

[1] "On Fossil Cycadean Stems from the Secondary Rocks of Britain." Trans. Linn. Soc. London, xxvi.

a gymnosperm. This plant, and a few of its immediate allies, afford the only instances, so far known, of the preservation of the embryo in a fossil seed.[1]

In the whole arrangement of the floral organs, the presence of a pericarp, and the character of the seed, the fructification differs entirely from anything known in gymnosperms, and the inclusion of Bennettites in Saporta's class "pro-angiosperms" appeared justified on grounds of analogy if not of affinity.

So far, however, nothing whatever was known of the staminate organs of these plants, and no one suspected that the fructifications already known were other than unisexual. The complete elucidation of the subject was reserved for the American palæontologists, who possess a wealth of material for the investigation of Mesozoic Cycadophyta far exceeding anything that Europe can show. No less than sixty species of silicified cycadean trunks have now been described from the Mesozoic of America, ranging from the Upper Triassic to the Lower Cretaceous.

The specimens are often extremely numerous; thus the twenty-nine species from the Black Hills of South Dakota are represented by nearly 1000 more or less complete trunks. In fact, the Cycadophyta of the American Mesozoic are as important to the botanist as the gigantic saurians (with which they are often associated) are to the zoologist.

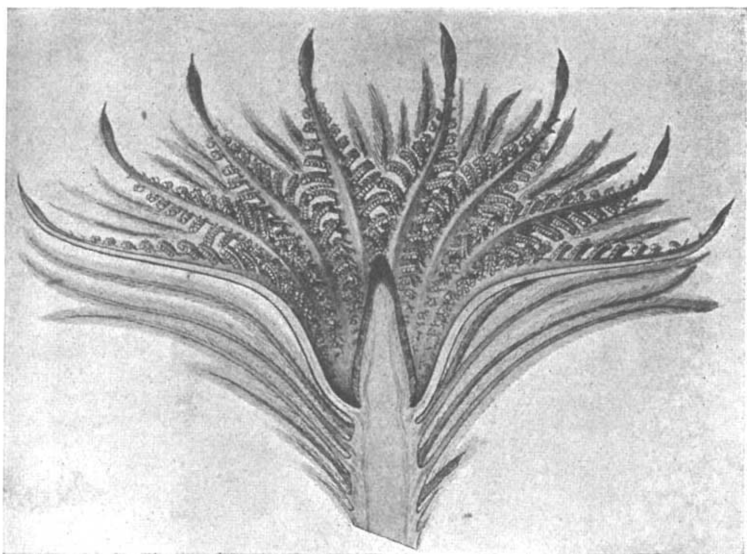

FIG. 2.—*Cycadeoidea ingens.* Restoration of an expanded bisexual flower in longitudinal section, showing the central ovuliferous cone, the compound stamens bearing numerous synangia, and the surrounding bracts, hairy with ramenta. About half natural size. From Wieland's "American Fossil Cycads."

Fig. 1 represents the first American fossil cycad ever discovered; it was found about 1860 in Maryland, between Baltimore and Washington, by the geologist, Philip Tyson, and well illustrates the external features of the group. A third of a century elapsed before any further discoveries were made, so the present magnificent material has been accumulated within quite a short period. The systematic arrangement of the specimens has been principally the work of Prof. Lester Ward, while the morphological investigation has fallen to the share of Dr. Wieland, of Yale University, to whom the discoveries we have now to consider are due. In referring to Dr. Wieland's work, I shall follow him in using the name Cycadeoidea, but it must be understood that this is synonymous, so far as we can tell, with Bennettites.

In external features, as well as in anatomical structure, the American species so far investigated agree wonderfully closely with the European species of Bennettites, but it must be remembered that the vast extent of the material will necessitate many years of arduous research before its investigation can be completed. During the eight years or so that Dr. Wieland has been at work, a marvellous amount has been accomplished. His results are embodied in a magnificent volume issued last August by the Carnegie Institution of Washington.[1]

The male organs of the Bennettiteæ were first found in 1899, in the species *Cycadeoidea ingens*.[2] Two years later the important fact was established that the organs of both sexes occurred in the same fructification, the whole thus constituting a "hermaphrodite," or bisexual flower.[3] Twenty-five trunks bearing bisexual flowers have now been investigated, belonging to seven American species. The conditions in *Cycadeoidea dacotensis*, one of the cases most fully investigated, are as follows. The whole fructification has a length of about 12 cm., and protrudes beyond the leaf-bases of the trunk. About half the length is occupied by the peduncle, the upper part of which bears 100 or more spirally arranged bracts, enclosing the essential organs. The centre is occupied by the ovuliferous cone, about 4 cm. in height, corresponding to the receptacle, with its seeds and other appendages, as found in *Bennettites Gibsonianus*. In *C. dacotensis*, however, the stage of development is far earlier, immature ovules taking the place of the ripe seeds of the more advanced European specimens. We have to do, then, in this case with an organ in the stage of a *flower*, as distinguished from the *fruit* previously described. The ovuliferous cone, or gynæcium, is completely surrounded by the hypogynous staminate disc, as Dr. Wieland calls it, springing from the rim of the receptacle at the base of the cone (see diagram, Fig. 2). The stamens are numerous (eighteen to twenty in *C. dacotensis*), and arranged in a whorl; their stalks are united to form a continuous sheath, which extends to about the level of the top of the gynæcium. Here they become free from each other; each stamen is a compound, pinnate sporophyll, about 10 cm. long altogether, and is folded inwards towards the gynæcium, the deflexed tip reaching down nearly to its base. The alternate pinnæ, of which there are about twenty pairs, are likewise bent inwards. The pinnæ, with the exception of those at the apex and base of the frond, which are sterile, bear the pollen-sacs in two rows, ten in each row on the longest pinnæ. Thus the stamens are highly complex organs, resembling the fertile fronds of a fern rather than the stamens to which we are accustomed in our modern flowering plants. The complexity, however, does not end here, for each pollen-sac is itself a compound structure containing two rows of loculi, ten or more in each row. It thus constitutes a *synangium*, comparable to that of the marattiaceous ferns, and especially the genus Marattia. The similarity to the fructification of such a species as *Marattia Kaulfussii* is, in fact, surprisingly close.

It appears that all the specimens actually investigated were in the bud condition, the stamens being still infolded, as described above. Presumably the stamens eventually opened out, and the diagrams introduced in Figs. 2 and 3 show them in the expanded condition. The ground-plan of the open flower, shown in Fig. 3, is based on *Cycadeoidea ingens*, a species in which the number of stamens is smaller than in *C. dacotensis*.

The leading features in the organisation of the Bennettitean flower may be briefly recapitulated as follows:—The centre is occupied by the gynæcium, seated on the convex receptacle, and consisting of numerous long-

[1] Solms-Laubach, "On the Fructification of *Bennettites Gibsonianus*." English translation in Ann. of Bot., v. 1891.

[1] "American Fossil Cycads." By G. R. Wieland (1906).

[2] "A Study of some American Fossil Cycads." Part i. The Male Flower of Cycadeoidea. Amer. Journ. Science, vii., 1899.

[3] Op. cit., Part iv. On the Microsporangiate Fructification of *Cycadeoidea*, Amer. Journ. Science, xi., 1901.

stalked ovules, imbedded among the interseminal scales. Surrounding this central body is the hypogynous whorl of stamens, fused below to form a tube, and expanding above into the pinnate sporophylls, bearing very numerous compound pollen-sacs or synangia, filled with pollen. The whole is surrounded by an envelope of spirally arranged bracts springing from the upper part of the peduncle. The general arrangement of parts is manifestly just the same as in a typical angiospermous flower, with a central pistil, hypogynous stamens, and a perianth. The resemblance is further emphasised by the fact, long known, that the interseminal scales are confluent at their outer ends to form a kind of pericarp or ovary-wall. When to these general features we add the practically exalbuminous character of the seed, with its highly organised dicotyledonous embryo, the indications of affinity with the higher flowering plants become extremely significant. The comparison was drawn by Dr. Wieland in 1901, immediately on his discovery of the hermaphrodite flower. The angiosperm which he specially selected for comparison was the tulip-tree, Liriodendron. The elongated strobiloid fruit, with many carpels spirally arranged in the receptacle, no doubt suggests similarity, and, on general grounds, we should naturally look for analogies among the less specialised polypetalous dicotyledons, such as Magnoliaceæ, in some of which the leaves of the perianth are spirally arranged. Analogies may also be found in our familiar Ranunculaceæ, such as Anemone, or, still better, the globe-flower (Trollius), with its numerous sepals, or, again, in the water-lilies (Nymphæaceæ). In certain respects, indeed, the Bennettitean flower was in advance of these more primitive dicotyledons, as seen in the arrangement of the stamens, which have abandoned the spiral phyllotaxis of the other organs to range themselves in a definite whorl, while at the same time their stalks are fused into a tube, thus becoming "monadelphous," as in the mallows of our own flora.

The flower, with its great stamens, 10 cm. long in some species, must have been a striking object when it opened (Figs. 2 and 3). As, of course, we can know nothing of the coloration of the perianth and other parts, we cannot tell how brilliant its appearance may have been; the bright tints of the carpels and ovules in some recent cycads, such as species of Cycas and Encephalartos, suggest the probability that the attractions of colour were not wanting to the more elaborate flowers of the older Cycadophyta; the possibility of a relation to the insect life of the period cannot be ignored. It is not my intention to push further the comparison of the Bennettitean fructifications with the angiospermous flower; the deeply interesting questions which must suggest themselves to the mind of every botanist, as to how far these manifest analogies are likely to indicate an immediate affinity, will be fully discussed elsewhere by others. Enough has been said to show that the remarkable organs discovered by Dr. Wieland fully merit the name of "flower," in the same sense in which we apply it, in everyday language, to the flowers of our gardens and fields.

As stress has been laid so far on the points of agreement with the flower of the angiosperms, some reference must now be made to characters which indicate relations in other directions. The structure of the gynæcium renders it probable, if not certain, that the Bennettiteæ were still gymnosperms as regards their mode of pollination, for the openings between the scales of the pericarp leave the micropyles of the seeds exposed. One must therefore suppose that the pollen was received by the ovule directly, without the intervention of a stigma, so that functional angiospermy had not yet been attained. This is, no doubt, a primitive condition, but it by no means excludes an affinity with angiosperms. Just as in Lagenostoma, the seed of the pteridosperm Lyginodendron, the beak of the nucellus was still the receptive organ for the pollen, in spite of the presence of an integument,[1] so, in the Bennettitean flower, the micropyle of the seed was still the receptive organ in spite of the presence of a pericarp. The integument in the one case and the pericarp in the other might be termed a "prophetic organ" in the only sense in which such organs exist, *i.e.* an organ which has not yet assumed all the functions to which it is destined.

The stamens, while by their arrangement and position they suggest those of a typical angiosperm, carry us back by their structure and form to the sporophylls of a fern (see Figs. 2 and 3), so that the characters of the flower as a whole may almost be said to bridge the gulf between cryptogams and the higher flowering plants. The fern-like characters, however, have probably come to the Bennettiteæ, not directly from true ferns, but through the intermediate group of the Palæozoic pteridosperms. The fact that the pollen-grains are borne in compound pollen-sacs, or synangia, like those of the Marattiaceæ among ferns, is one of great significance.[2] It is impossible to emphasise too strongly the extraordinary combination of characters which the Bennettitean flower presents, uniting in itself features characteristic of the angiosperms, the gymnosperms, and the ferns, and suggesting that the passage from the Filicineæ to the higher flowering plants may have been (comparatively speaking) a short cut. The complexity of this earliest known type of a true flower indicates the probability, as Dr. Wieland points out,[3] that

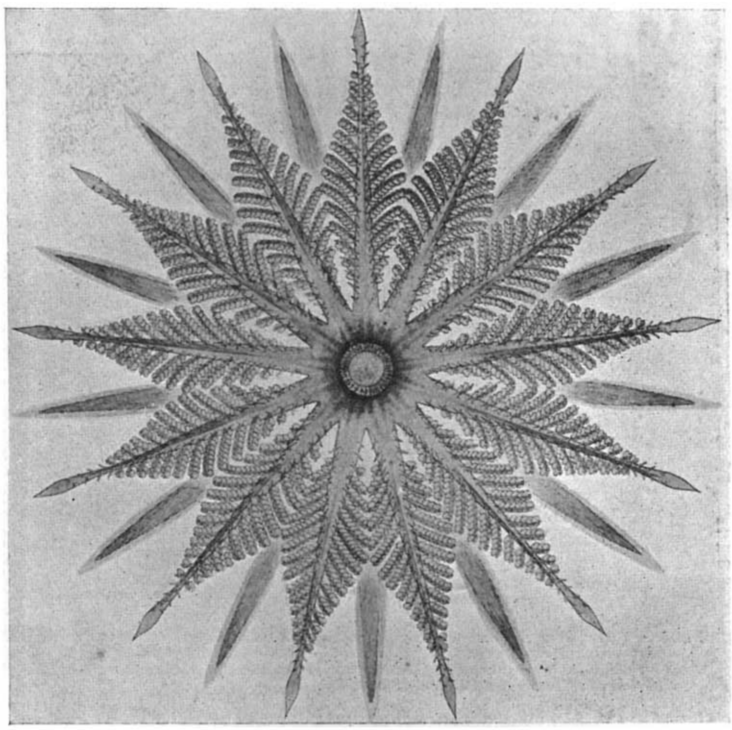

FIG. 3.—*Cycadeoidea ingens.* Plan of bisexual flower consisting of a central ovuliferous cone, a hypogynous whorl of compound stamens, united at the base, and a series of spirally inserted enveloping bracts, all shown diagrammatically on about the same scale as Fig. 2, and as if pressed out flat. From Wieland's "American Fossil Cycads."

1 See Oliver and Scott, "On the Structure of the Palæozoic Seed *Lagenostoma Lomaxi*," Phil. Trans. Roy. Soc., Series B., 197 (1904), p. 231.

2 The general question of the relation of the early seed-plants to fern is discussed in my article, "On the Present Position of Palæozoic Botany," Progressus Rei Botanicæ, Heft 1. 1906.

3 "American Fossil Cycads," p. 143.

the evolution of the angiospermous flower was a process of reduction. There is thus no longer any presumption that the simplest forms among the flowers of angiosperms are likely to be the most primitive. The tendency of the older morphologists to regard such flowers as reductions from a more perfect type appears fully justified by the discovery of the elaboration of floral structure attained by the Mesozoic Cycadophyta before the advent of the angiosperms themselves.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The special board for biology and geology has approved a grant of 150*l.* from the Balfour fund made by the Balfour managers to W. E. Agar, of King's College, in furtherance of his proposed expedition to the Paraguayan Chaco.

The board of agricultural studies reports that the fund for providing the department of agriculture with a permanent building of its own has received substantial additions during the year, the conditional contribution of 5000*l.* by the Drapers' Company having been secured. The fund now amounts to 13,030*l.* 10*s.*

MANCHESTER.—Mr. F. T. Swanwick, Richardson lecturer in mathematics, has been appointed Fielden lecturer in mathematics in place of Mr. R. F. Gwyther, who is now devoting his whole time to the joint matriculation board of the northern universities. Mr. J. E. Littlewood (Cambridge) has been appointed Richardson lecturer in mathematics; he was bracketed senior wrangler in 1905, and was placed in the first division of the first class of part ii. of the mathematical tripos in 1906. Mr. H. M. Priestley (Cambridge) has been appointed assistant lecturer in mathematics; he was fifth wrangler in 1905, and was placed in the second division of the first class of part ii. of the mathematical tripos in 1906.

Plans have been prepared for new engineering laboratories, and building will shortly be commenced on a site on the north side of Coupland Street, near the present physical laboratories. For some time past need has been felt for this extension, and the new buildings will afford ample space for the whole work of the engineering department to be carried out under one roof. In addition to the main laboratory of 75 feet by 166 feet, lecture rooms, a large drawing room, and a boiler house are to be erected.

SIR ARTHUR RÜCKER, F.R.S., principal of the University of London, will distribute the prizes to the successful students at Guy's Hospital on Thursday, July 4.

SIR JOHN KENNAWAY, BART., M.P., will preside at the commemoration day proceedings of Livingstone College, Leyton, E., on Wednesday, June 5. Livingstone College exists for the purpose of solving one of the greatest problems connected with missionary effort, viz. the preservation of the health of missionaries and others in tropical climates.

IT is stated in *Engineering* of May 24 that the Technikum at Ilmenau, in Thuringia, is one of the few technical schools that are conducted in direct connection with commercial works. The director is also head of a firm of engineering and electrical works, and the students are, at all times, when not occupied by their regular lectures and laboratory practice, admitted into the works, in which advanced pupils can receive further training. The combination seems to answer.

IN the *Engineering Magazine* (vol. xxxiii., No. 2) Mr. H. Cole Estep discusses the attitude of technical students towards the engineering-apprenticeship courses which are offered by the leading manufacturers of the United States. He finds the attitude unsympathetic. The present low flat-rate system of wages is discouraging rather than encouraging to the average college student. The objections are also raised that the courses are too long, that there is no reward at the end, and that the invention clause existing in many apprenticeship contracts is unfair.

A COURSE of instruction in natural history has been arranged at the Horticultural College, Swanley, for students who, having passed through the ordinary training in gardening, wish for additional training in natural-history subjects, in order to qualify as teachers of gardening and nature-study. Other students will be admitted to the course provided they can show they are able to take full advantage of the instruction. Students will be given an insight into field work in natural history based on laboratory instruction; the work will be practical, and students will be shown how to prepare their own material and to construct their own apparatus. The course will last a year, of which the first two terms will be devoted to general work in botany, zoology and geology, and the third term to special subjects. Fuller particulars may be obtained from the principal at the college, Swanley, Kent.

IN his presidential address to the Royal Geographical Society on Monday, May 27, Sir George Goldie again directed attention to the omission of geography in examinations for the Foreign Office and other branches of the Civil Service. For a good many years the Foreign Office stood in an exceptional position amongst the Civil Services of the Crown by including geography amongst the subjects for the entrance examinations of candidates and making a pass in this subject compulsory. After next month, however, geography will cease to be a subject which candidates for the Foreign Office may select even voluntarily. So many sons of the well-to-do classes of this country compete in examinations controlled by the Civil Service Commissioners that the standing in the whole educational sphere of any subject depends to some extent upon whether it is or is not a means of gaining marks in the civil and military examinations, and it may be asserted that if geography is included as one of the subjects of examination, it will very shortly take its place in Great Britain, as it has long since done in the United States, Germany, and other countries, as one of the fundamental and indispensable elements in the education of childhood and youth. That this has not been the case up to now is probably due to the unintelligent and unmethodical manner in which the subject was taught until a few years ago, with the result that the majority of those who are to-day in a position to speak with authority retain an entirely incorrect impression of its scope and objects. It is to the University of Oxford, supported, Sir George Goldie added, by the Universities of Cambridge, London, Edinburgh, and other great centres of education, that geographers must look for a satisfactory solution of this important question; for, so far as can be gathered from the correspondence on the subject which appeared some months ago, the Civil Service Commissioners are willing to consider the admission of geography as one of the voluntary subjects for examinations, provided the great universities will give a lead. In taking such a step, both the universities and the commissioners would have behind them the pressure of public opinion, owing to the sudden awakening both of interest in the Empire as a whole and of recognition of our widespread ignorance of its geographical conditions.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 31.—"On the Thermo-chemistry of Flame Spectra at High Temperatures." By Prof. W. N. **Hartley,** F.R.S.

(1) The oxides of calcium, strontium, and barium are not dissociated by heat alone, because they show no spectrum in a carbon monoxide flame; (2) they are reduced by the combined action of heat and hydrogen in the oxy-hydrogen flame and by the action of cyanogen in the cyanogen flame; (3) the flame coloration is due to the metal, because not only is the flame spectrum from lime essentially the same as that of the metal calcium, but also the heats of formation of CaO, SrO, and BaO have very nearly the same value, and that where calcium oxide can be reduced the other oxides could, on that account, undergo a similar reduction. Whether the compound of strontium or barium in the flame be a sulphide or an oxide, the same spectrum is emitted, but there is some